

# Diviner PDS Level 3 Data Products

Benjamin T. Greenhagen

JHU Applied Physics Laboratory

[benjamin.greenhagen@jhuapl.edu](mailto:benjamin.greenhagen@jhuapl.edu)

Joshua L. Bandfield

Space Science Institute

[joshua.bandfield@gmail.com](mailto:joshua.bandfield@gmail.com)

3/15/15

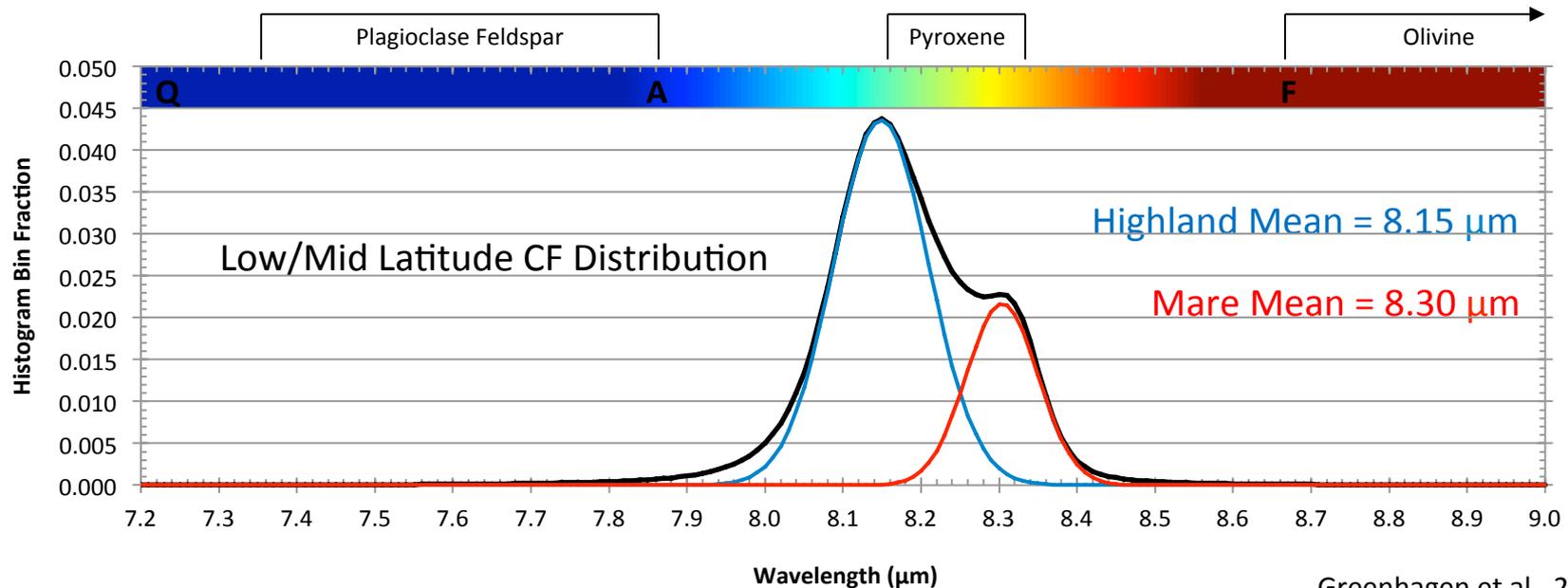
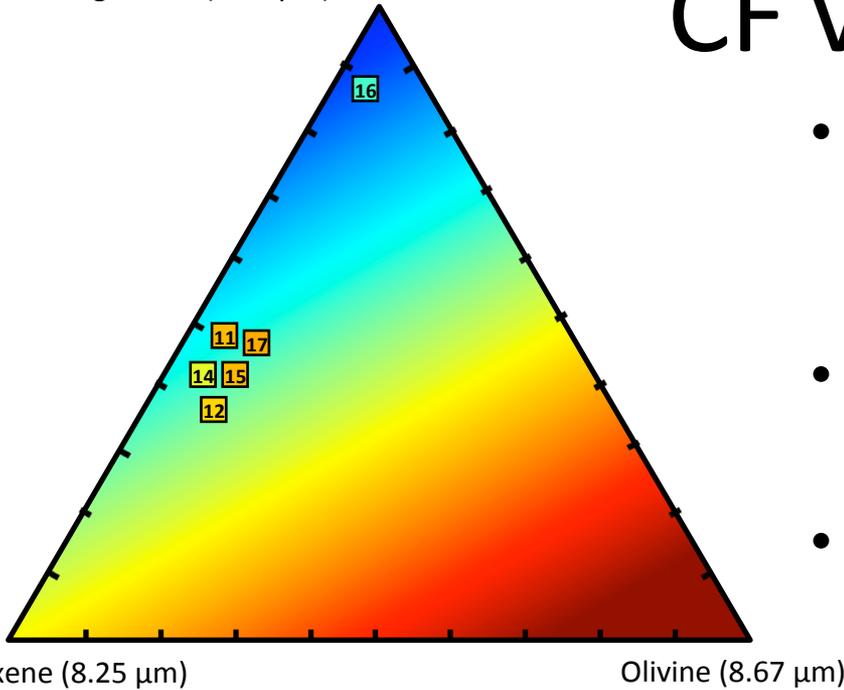
LRO Data User's Workshop, The Woodlands, TX

- What are the Diviner Level 3 Data Products?
  - Standard Christiansen Feature Value (STD\_CF)
    - Cumulative Map
  - Normalized to Equatorial Noon CF Value (NEN\_CF)
    - Cumulative Map
  - Rock Abundance (RA)
    - Cumulative Map, Individual Map Cycles
  - Soil Temperature (ST)
    - Cumulative Map, Individual Map Cycles
  - Normalized Soil Temperature (STN)
    - Cumulative Map
  - Root Means Square (RMS)
    - Individual Map Cycles
- These data products are available at 128 ppd
  - NEN\_CF is available at 32 ppd

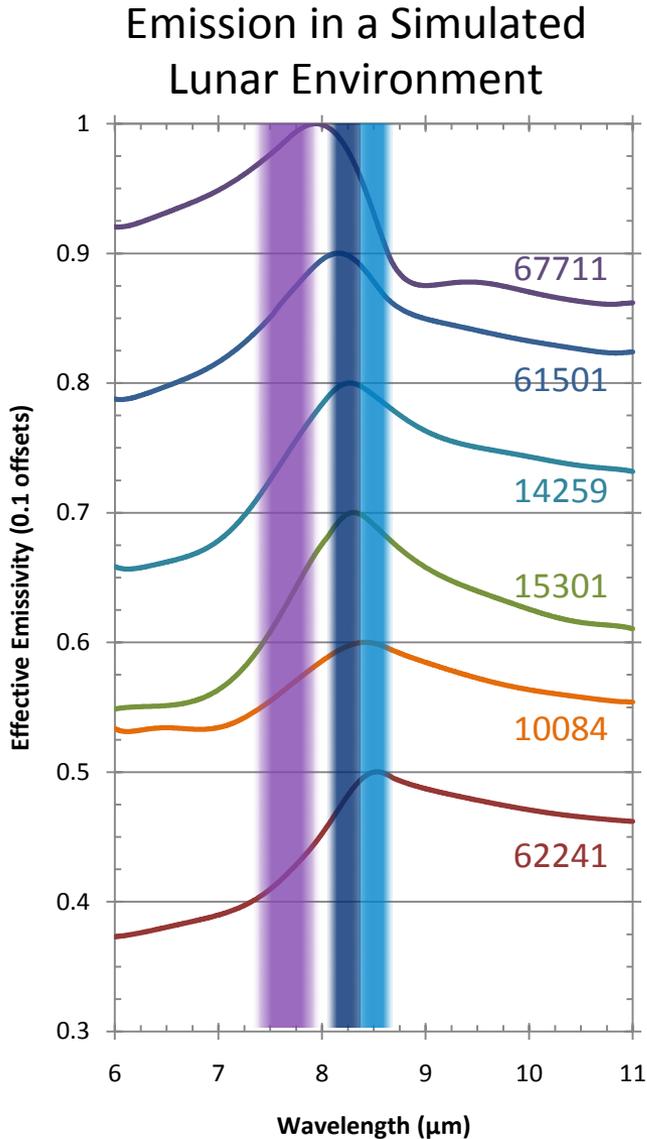
Plagioclase (7.86  $\mu\text{m}$ )

# CF vs. Composition

- CF shifts to shorter wavelengths with increasing silicate polymerization
- CF position is most sensitive to plagioclase/olivine abundance
- Pyroxene compositions are not unique



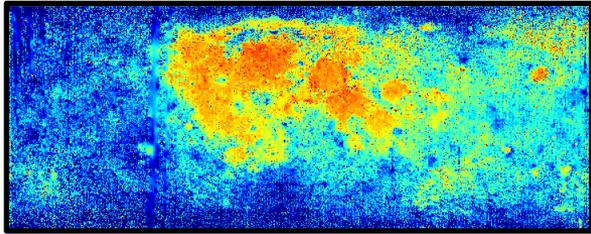
# 8- $\mu\text{m}$ Channel Compositional Data



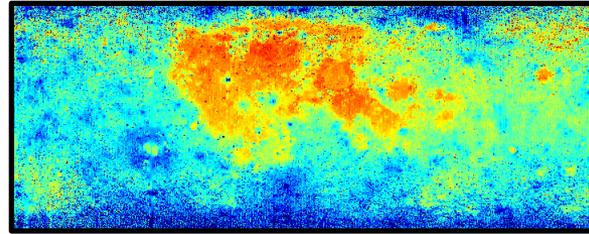
- CF of lunar soils in lunar environment is nearly parabolic
- Simultaneously solve three quadratic equations
- In brightness temperature space
  - $T_{b_{\text{Max}}} = C - B^2 / (4 * A)$
- Use  $T_{b_{\text{max}}}$  to calculate effective emissivity (unit emissivity at CF)
- In emissivity space
  - $CF_{\text{Val}} = -B / (2 * A)$
- CF value is defined as the modeled approximation of the CF

# Standard CF Value Maps (STD\_CF)

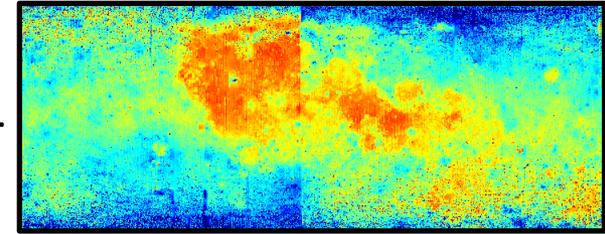
Map Cycle 13



Map Cycle 12



Map Cycle 11

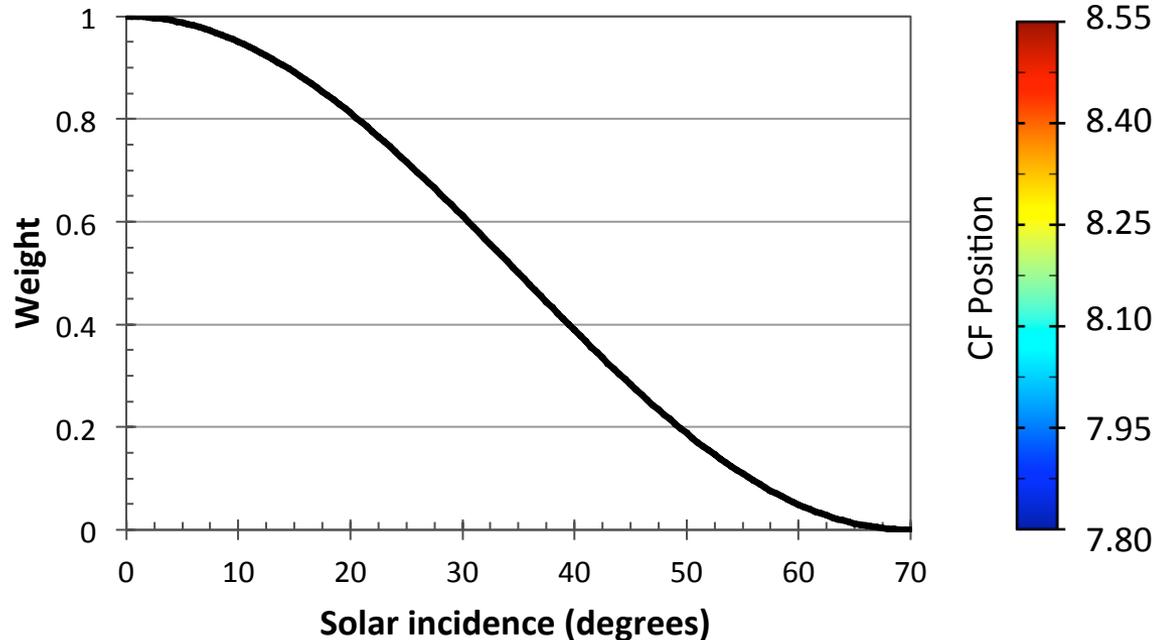


+ 43 others

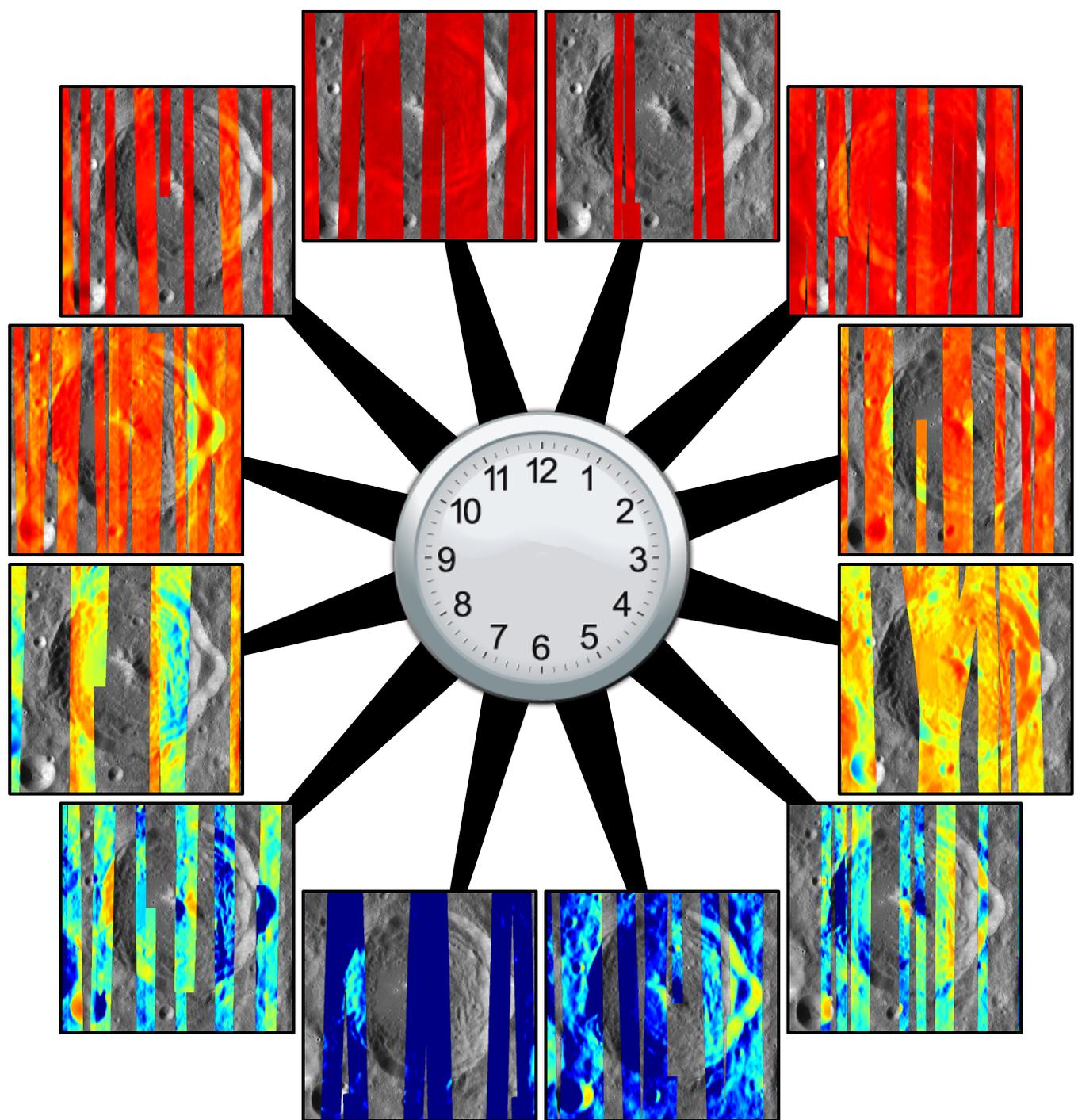
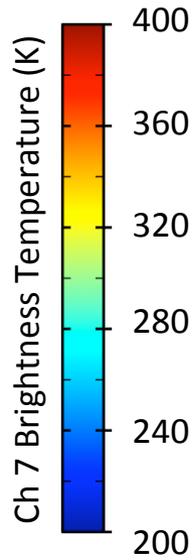
## Solar Incidence ( $i$ ) Weighting

$$wt = \frac{\cos\left(\frac{18}{7}i\right) + 1}{2}$$

Tb < 250 &  $i$  > 70  
are not used



# Equatorial Daytime Coverage

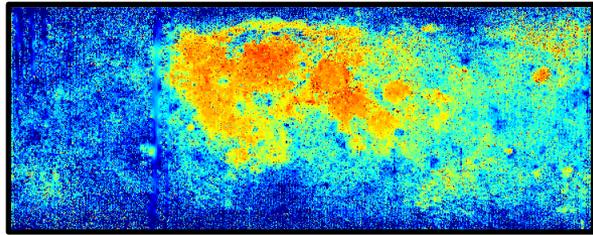


Green Crater  
133 E / 3.5 N

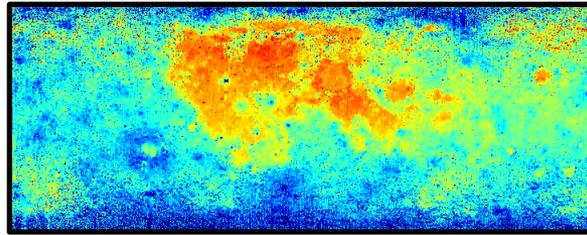
Science Mission  
+ Extended Mission

# Standard CF Value Maps (STD\_CF)

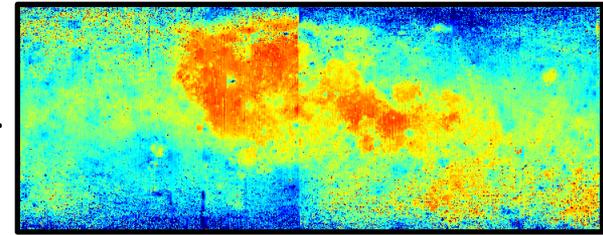
Map Cycle 13



Map Cycle 12



Map Cycle 11



+

+

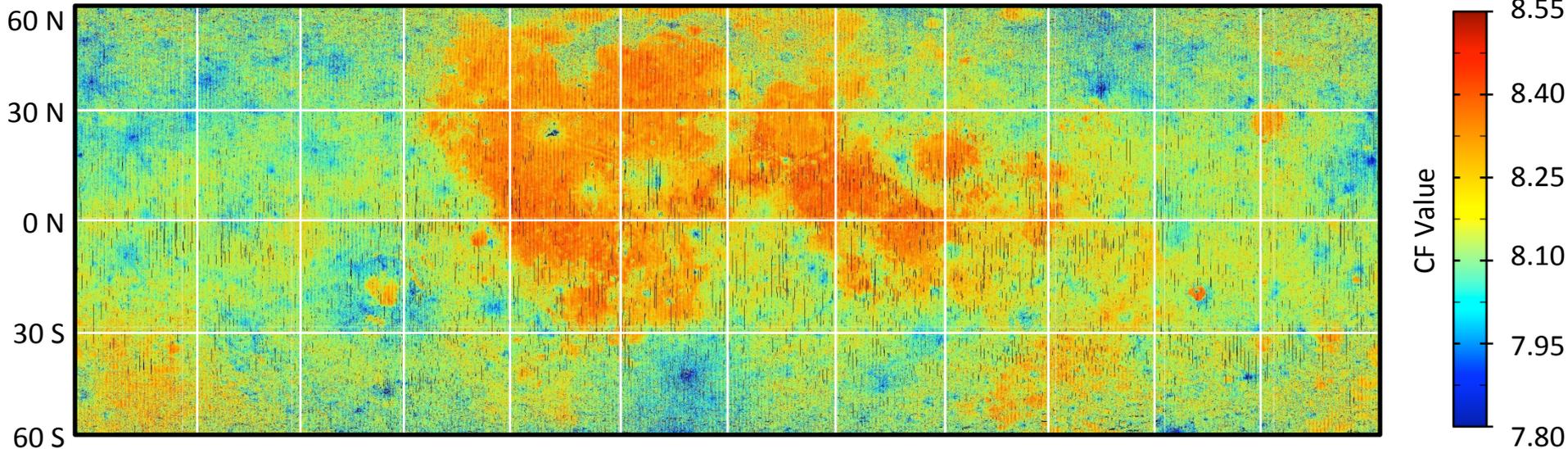
+ 43 others



Solar Incidence ( $i$ ) Weighting

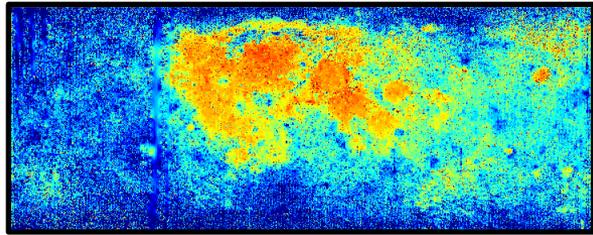


180 W      120 W      60 W      0 E      60 E      120 E      180 E

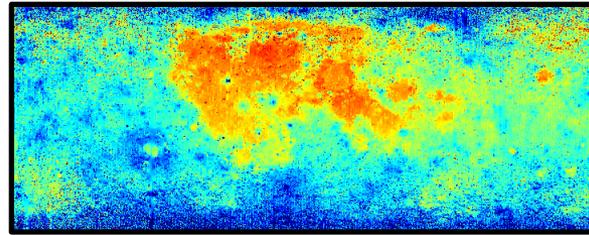


# Standard CF Value Maps (STD\_CF)

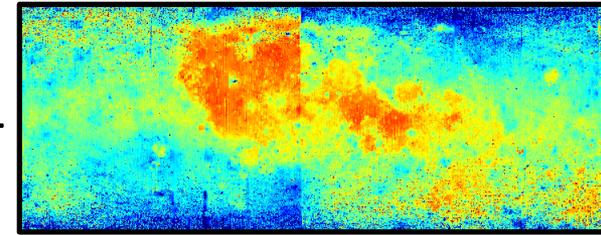
Map Cycle 13



Map Cycle 12



Map Cycle 11



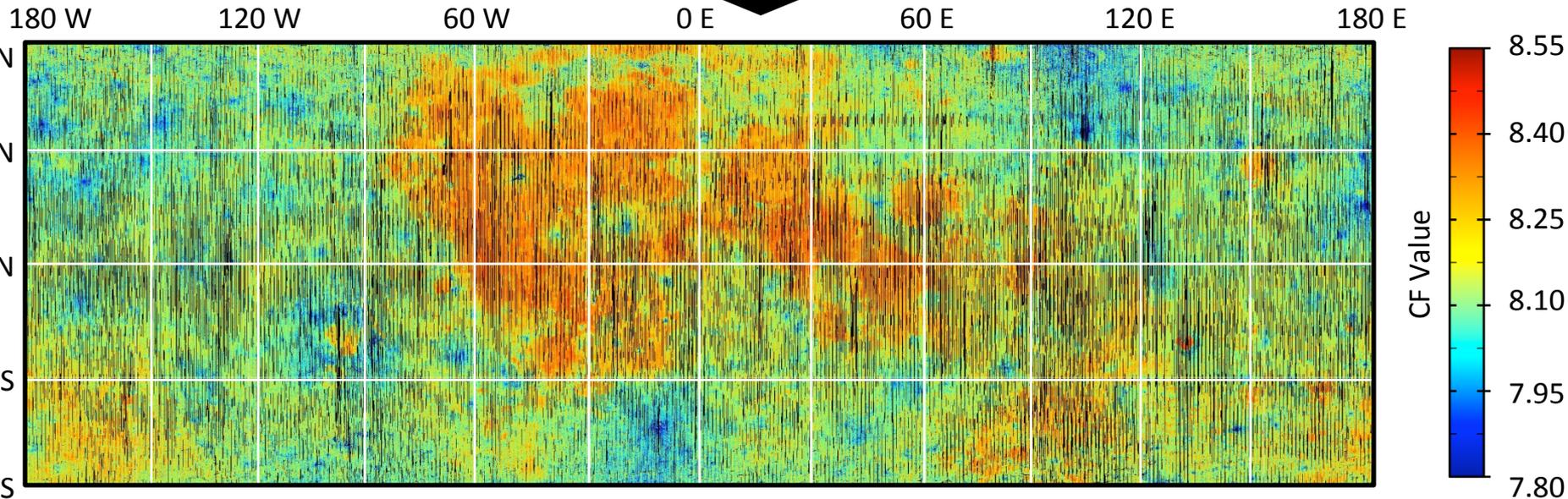
+

+

+ 43 others

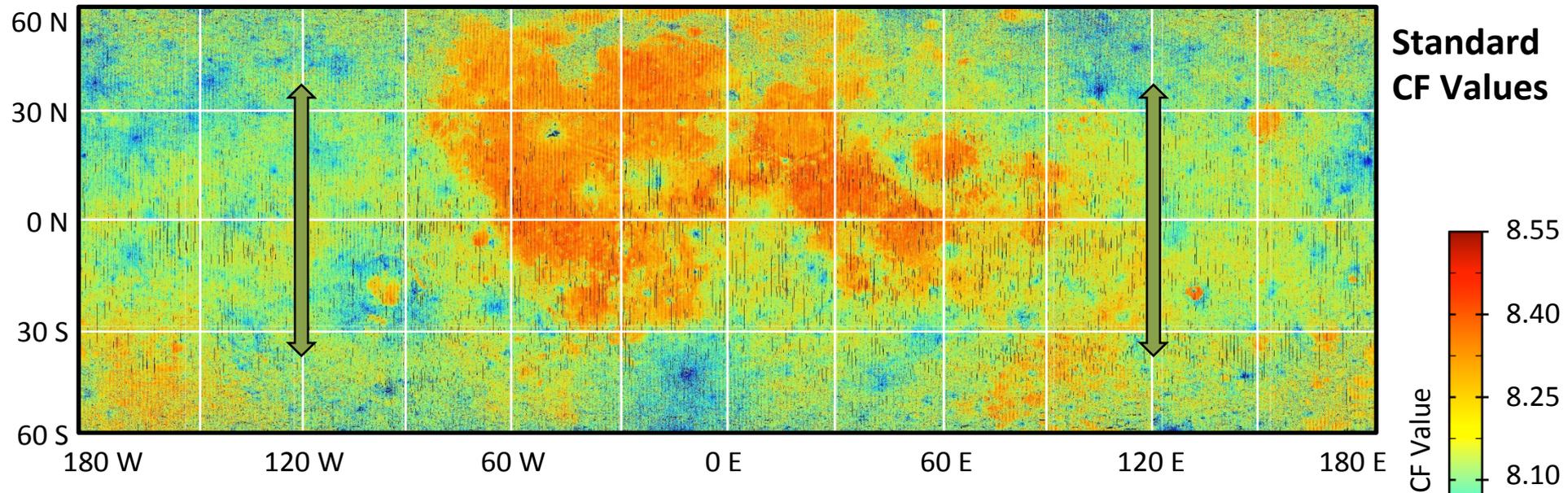


Solar Incidence ( $i$ ) Weighting

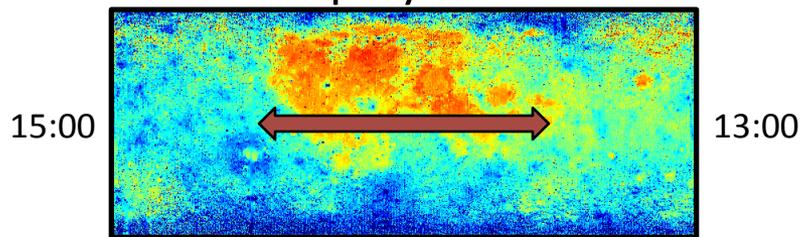


\* Previous STD\_CF map for comparison \*

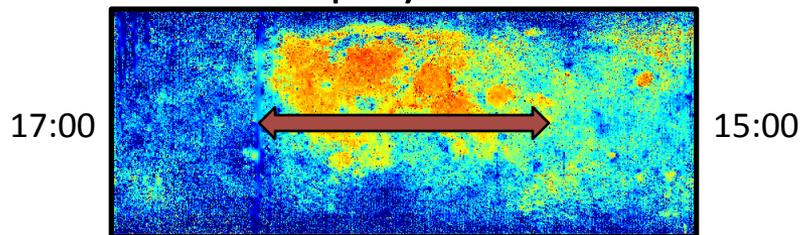
# Correcting Standard CF Value Maps



Map Cycle 12



Map Cycle 13

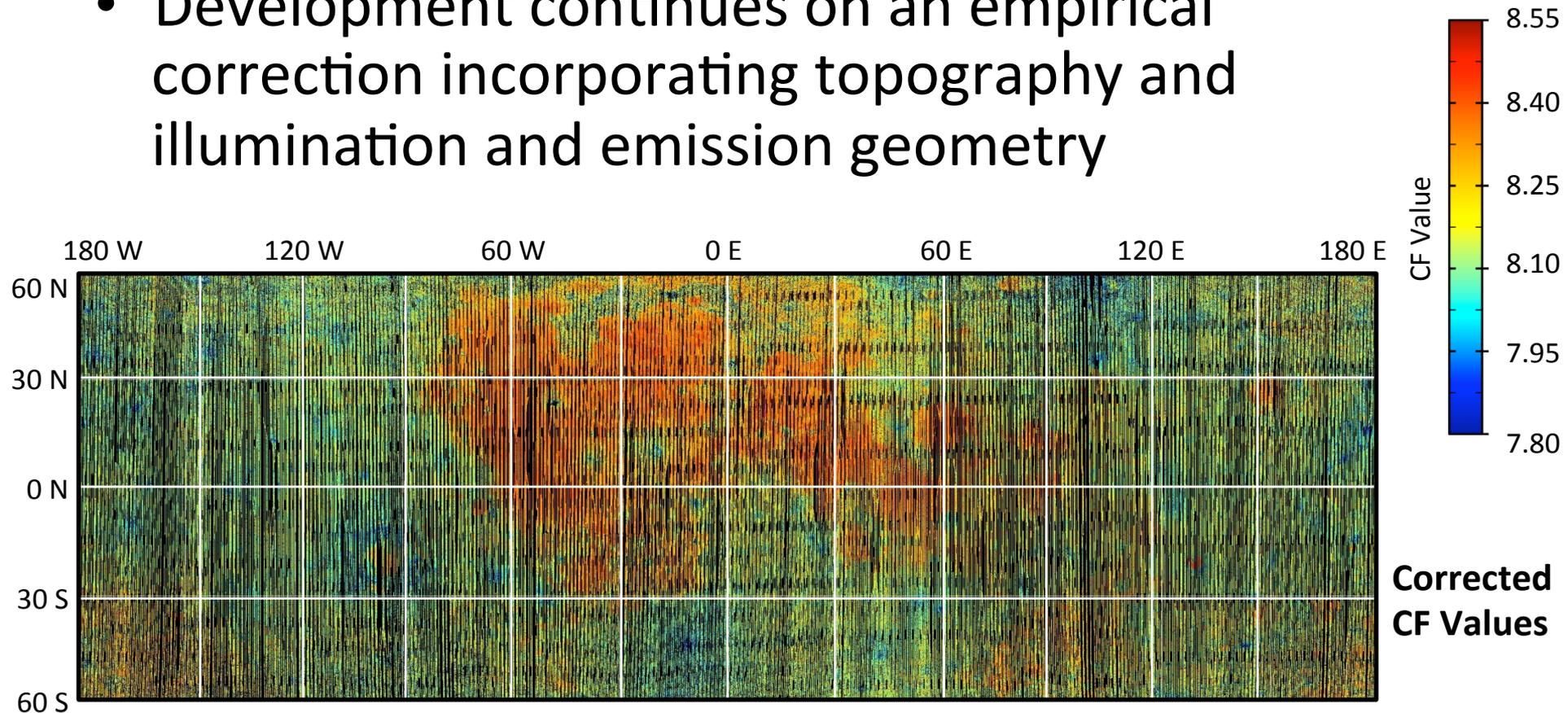


Variations with  
both **latitude**  
and **local time**

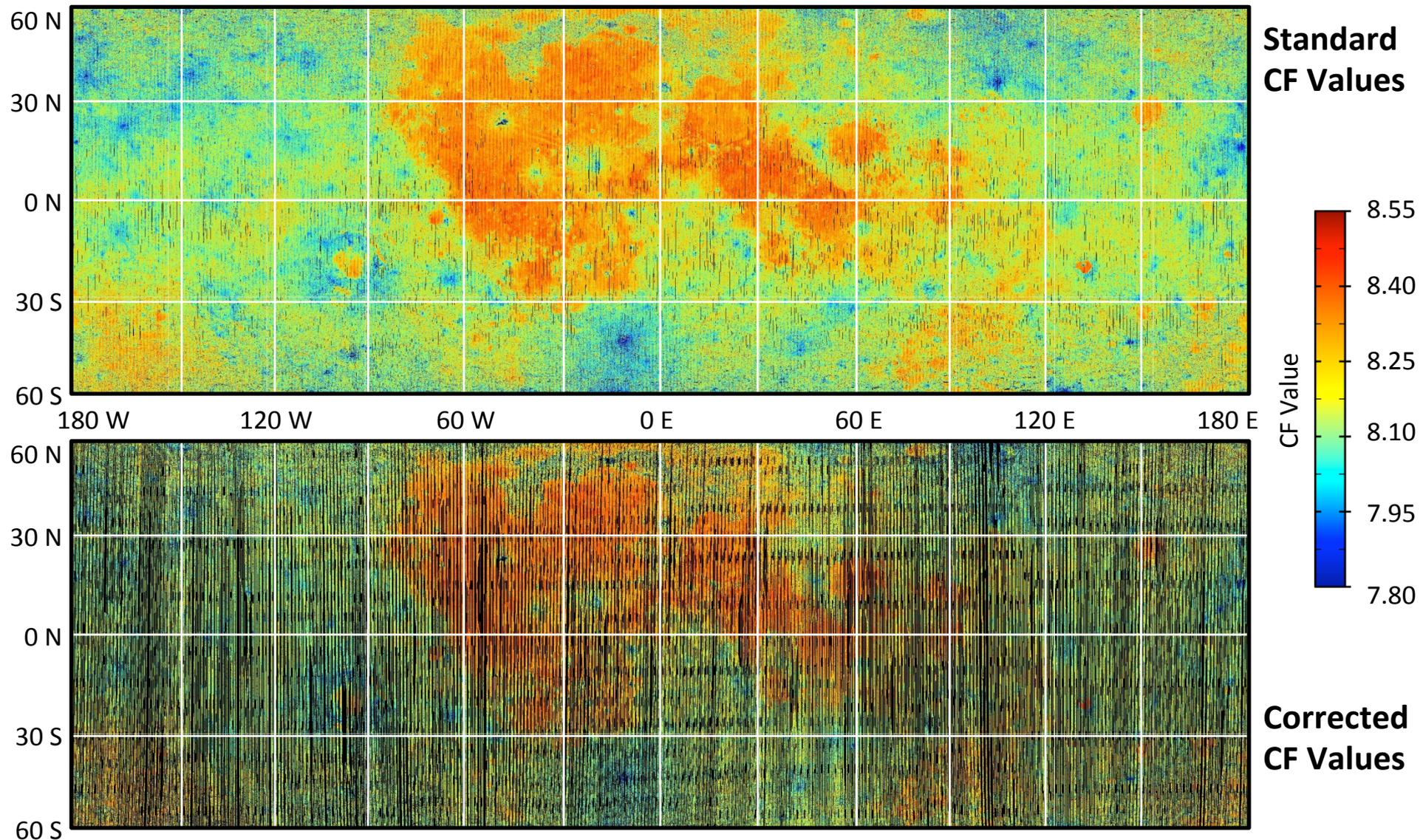
CF shifts to **shorter wavelengths**  
with increasing solar incidence

# Corrected CF Value Maps (NEN\_CF)

- March 2011 release includes corrected CF values from Greenhagen *et al.* 2010, (*Science*)
  - Corrects latitude and local time but NOT topography
- Development continues on an empirical correction incorporating topography and illumination and emission geometry



# Corrected CF Value Maps (NEN\_CF)



# Caveats for using Diviner CF Maps

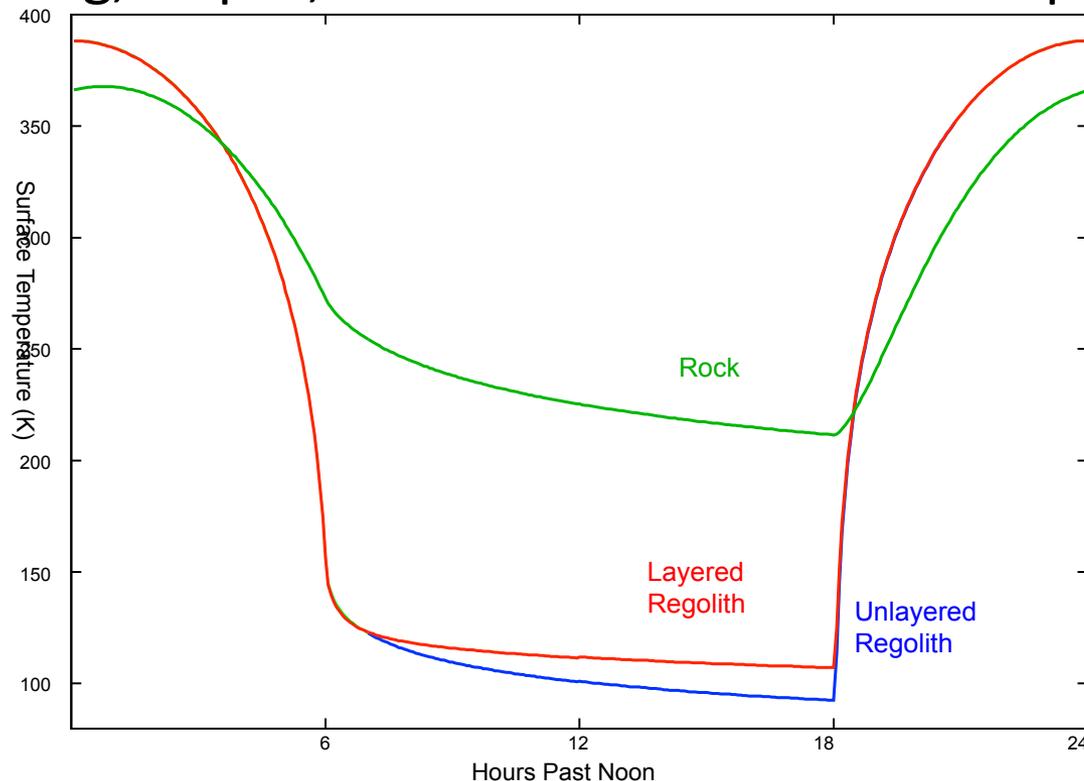
- The quality of a CF value is dependent on the solar incidence angle / viewing geometry
  - Topographic effects can be large
  - Generally OK for incidence angles less than 30 degrees
  - Plan to include a measure of confidence / uncertainty in future release
- Abnormal pixels are given fixed CF values
  - Caused by out of band compositions and/or poor data quality
  - SIS will be updated to include details
  - CF values outside 7 to 9.5 are not included
  - Investigating ways to report “good” abnormal pixels
- Effects of space weathering are not corrected
  - Generally  $\sim 0.1 \mu\text{m}$  for immature to mature
  - Plan to include space weathering correction in future release

# Lunar Thermophysics

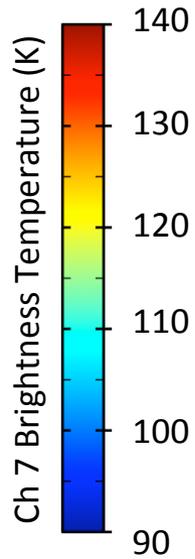
Nighttime temperatures are very sensitive to the physical nature of the surface

Rocks will stay  $\sim 100\text{K}$  warmer than the regolith throughout the night

Layering, slopes, etc. also affect surface temperatures

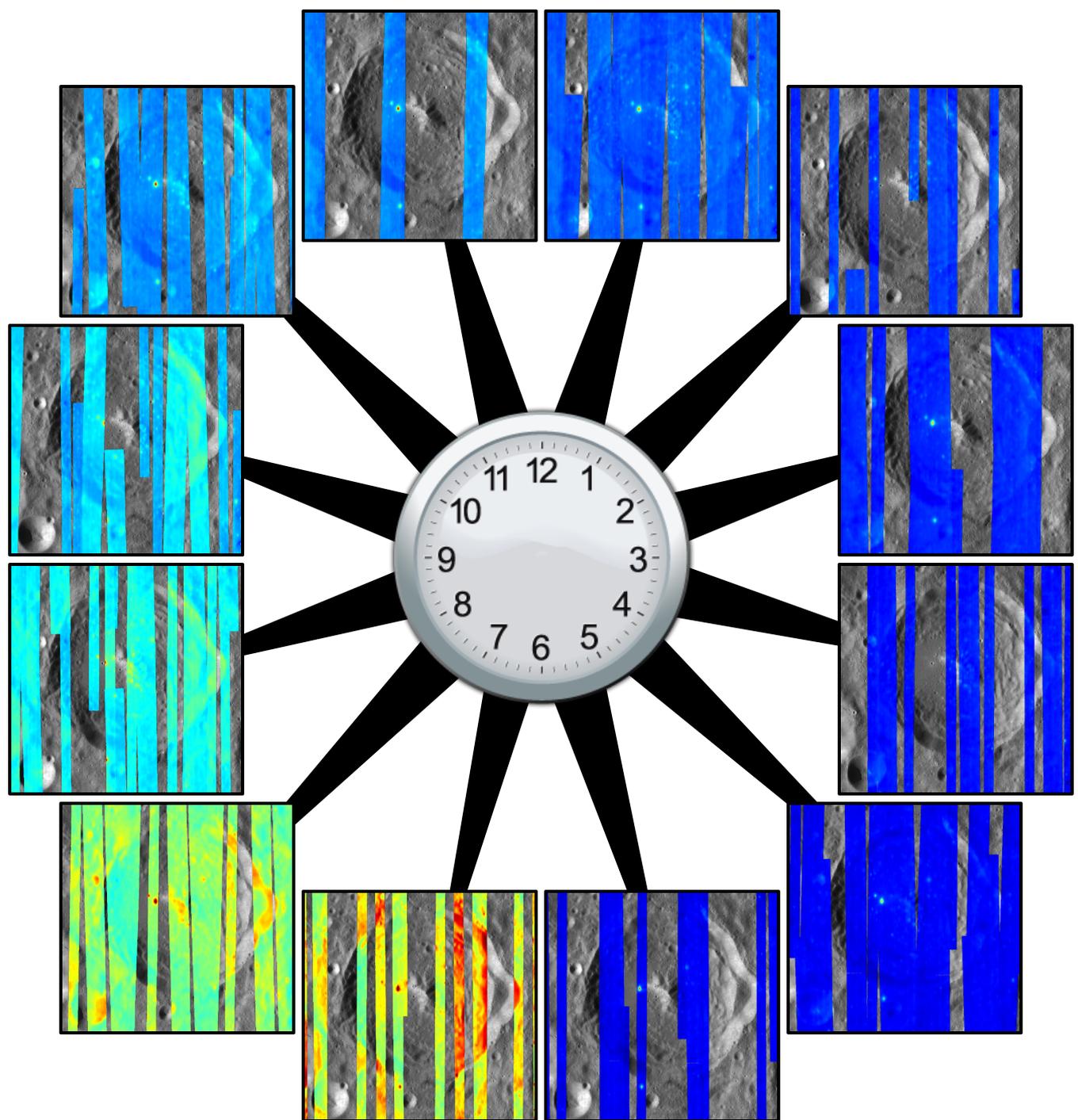


# Equatorial Nighttime Coverage

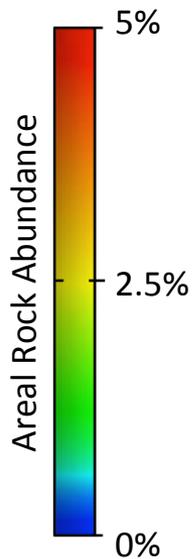
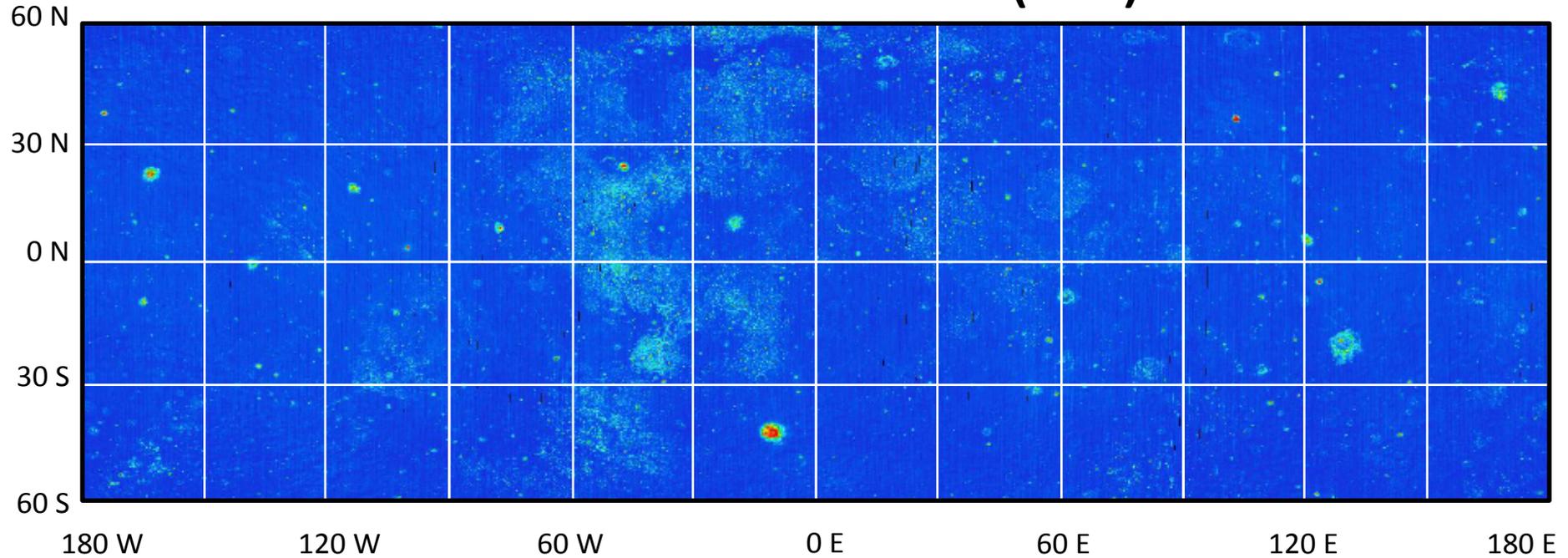


Green Crater  
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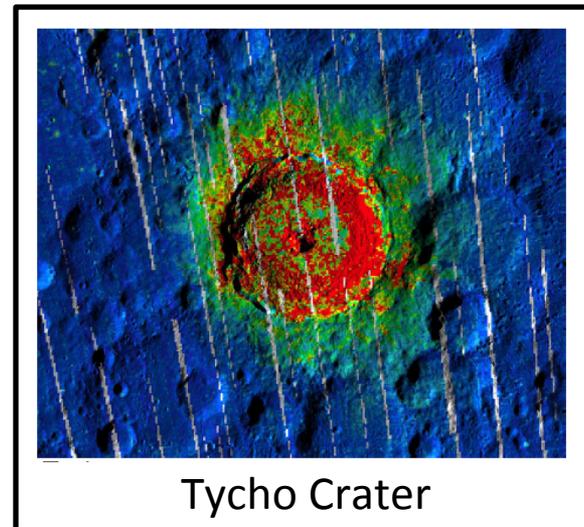
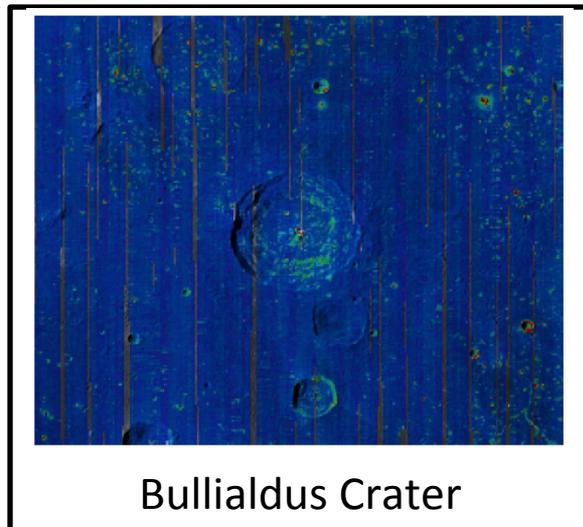
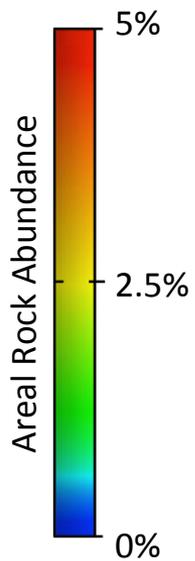
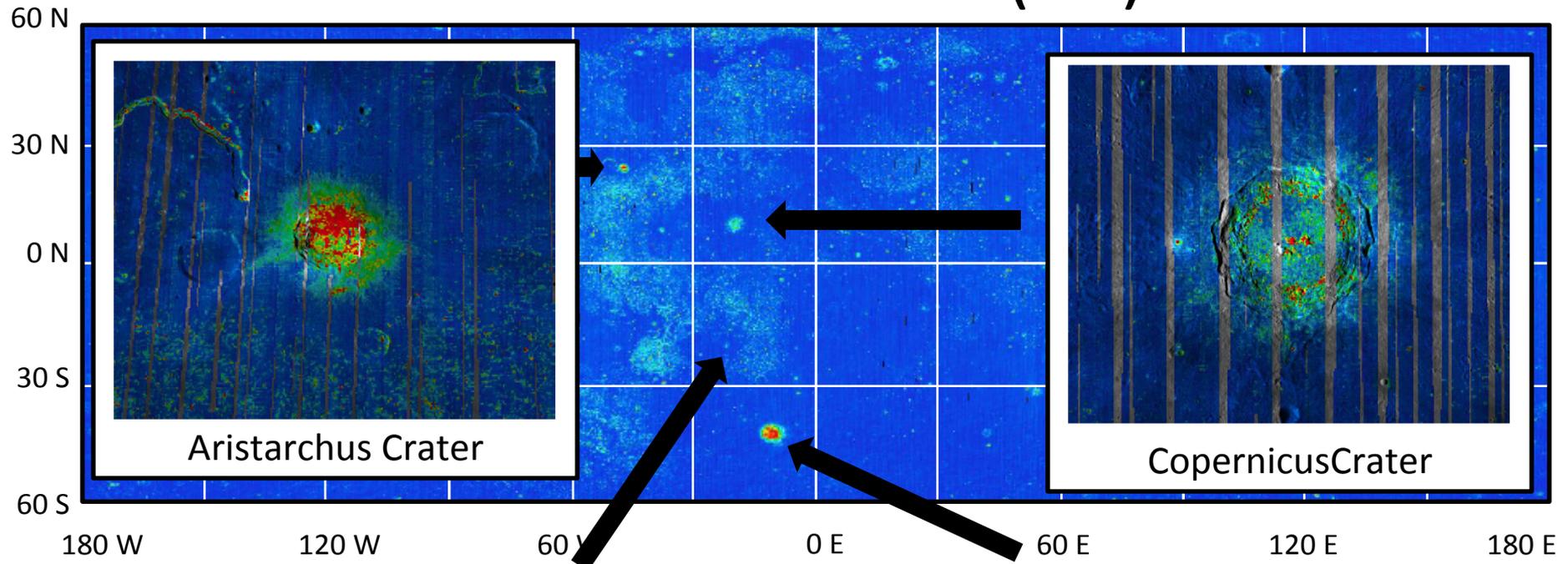


# Rock Abundance (RA)



- Model Uses Diviner chs 6-8 centered near 18, 35, and 75 mm
- Model temperature of rocks with latitude/local time and optimize modeled radiance by varying Soil Temperature (ST) and areal Rock Abundance (RA)
- Initial results provide realistic numbers and data are well-behaved
  - Younger craters show higher Rock Abundances (e.g. Tycho)

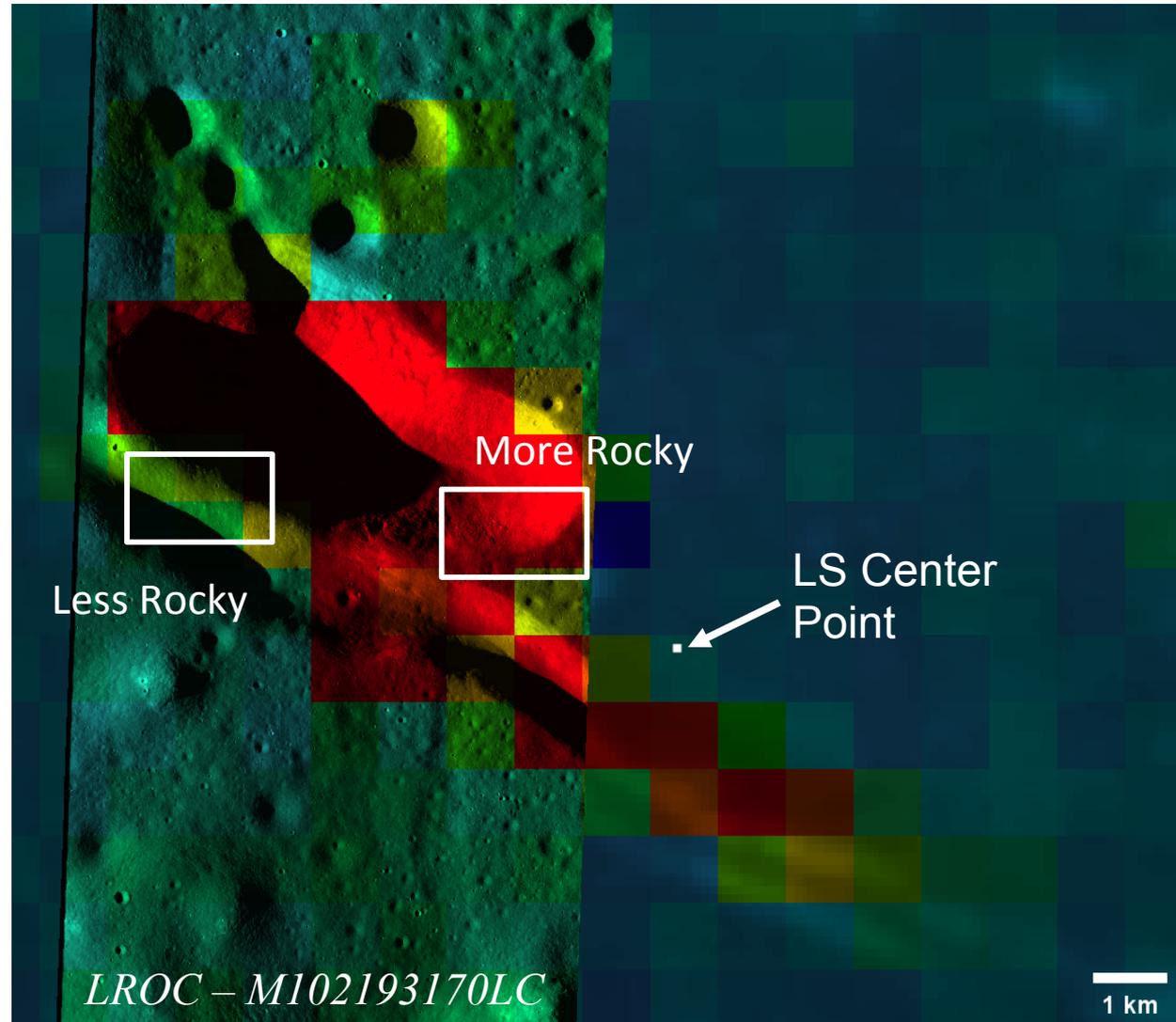
# Rock Abundance (RA)

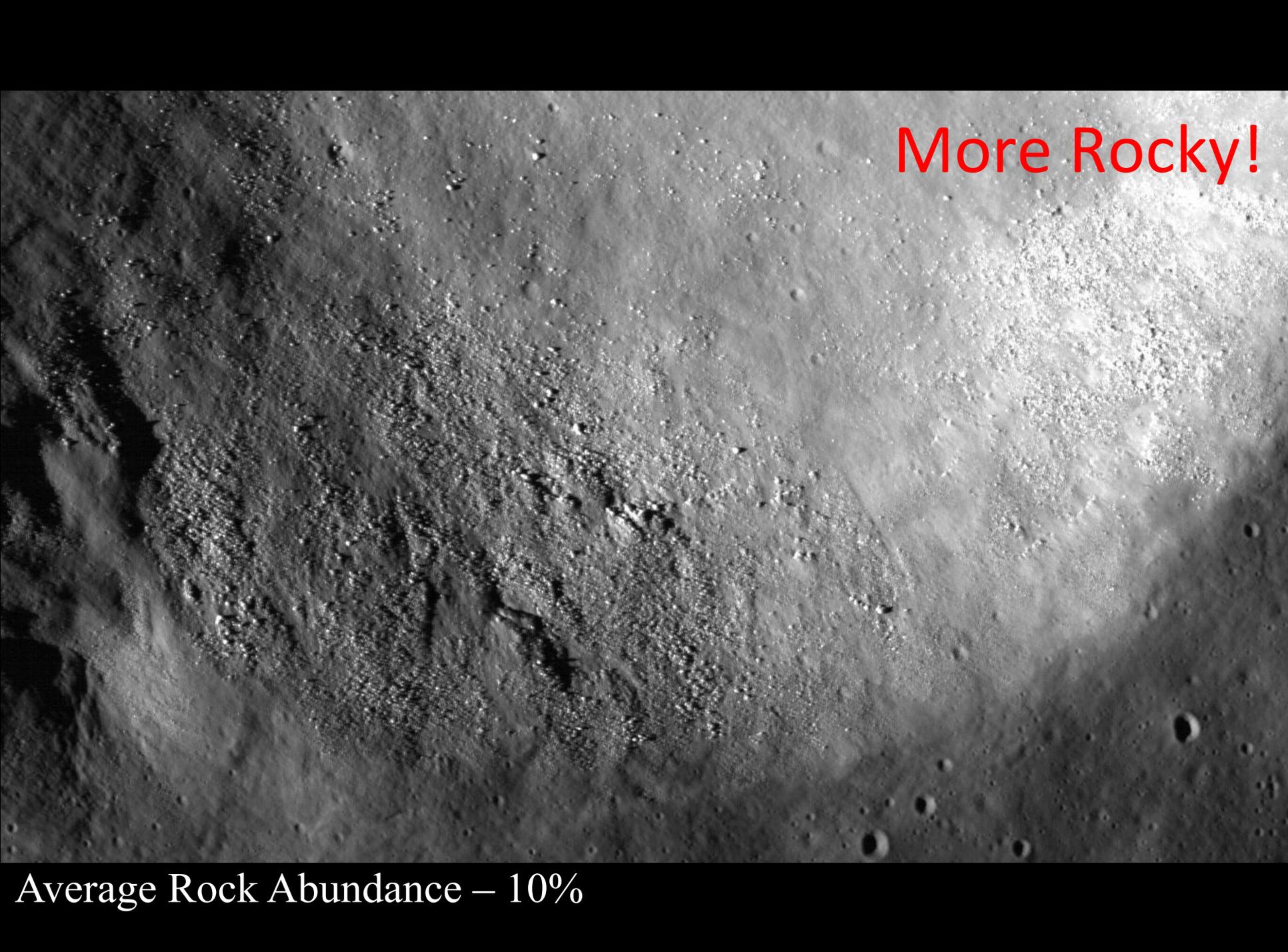


# Rima Bode Landing Site

Large spatial  
variability in rock  
abundance

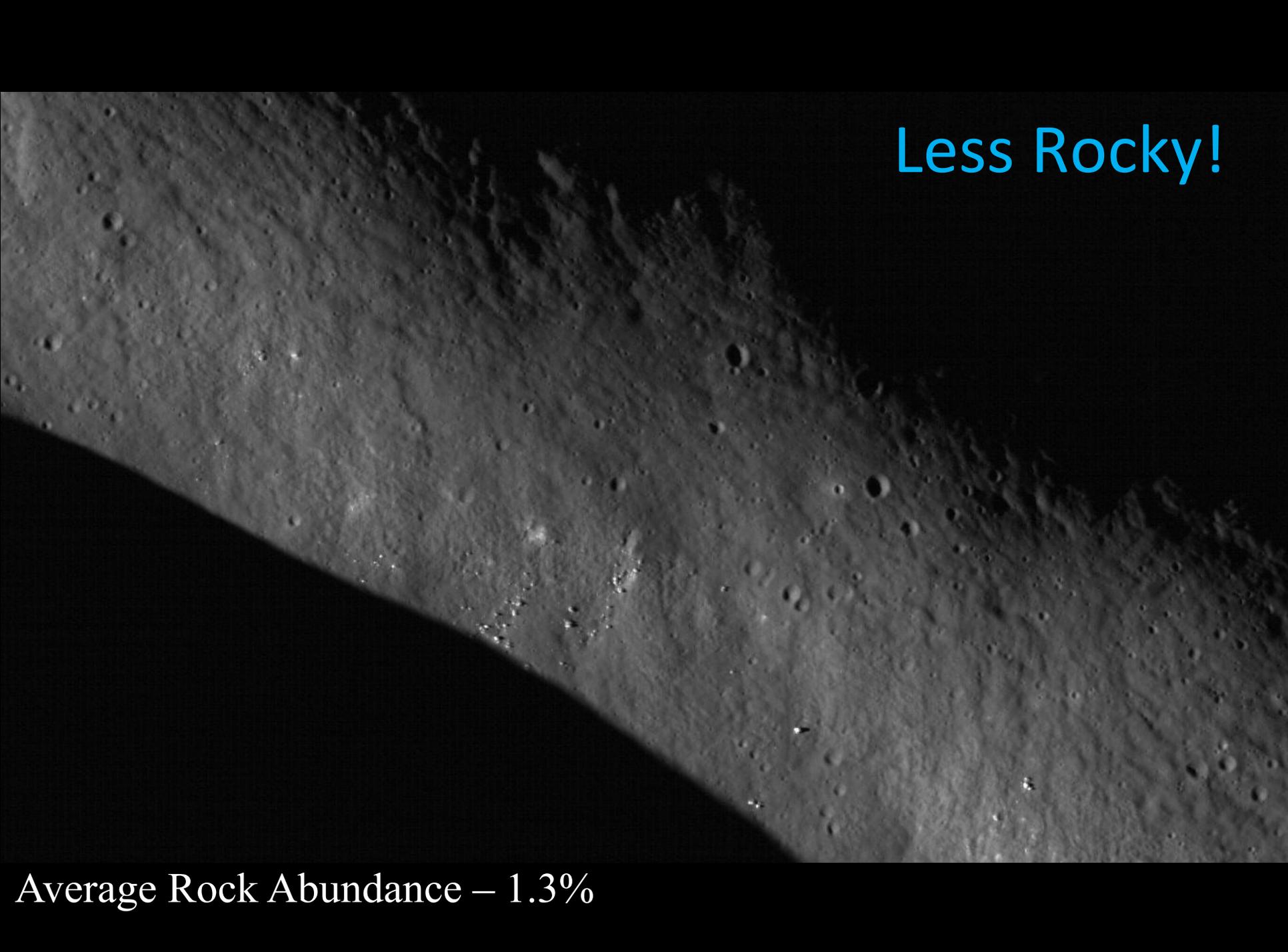
Comparisons with  
LROC NAC images  
show excellent  
qualitative  
agreement





More Rocky!

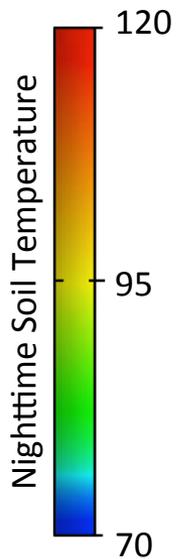
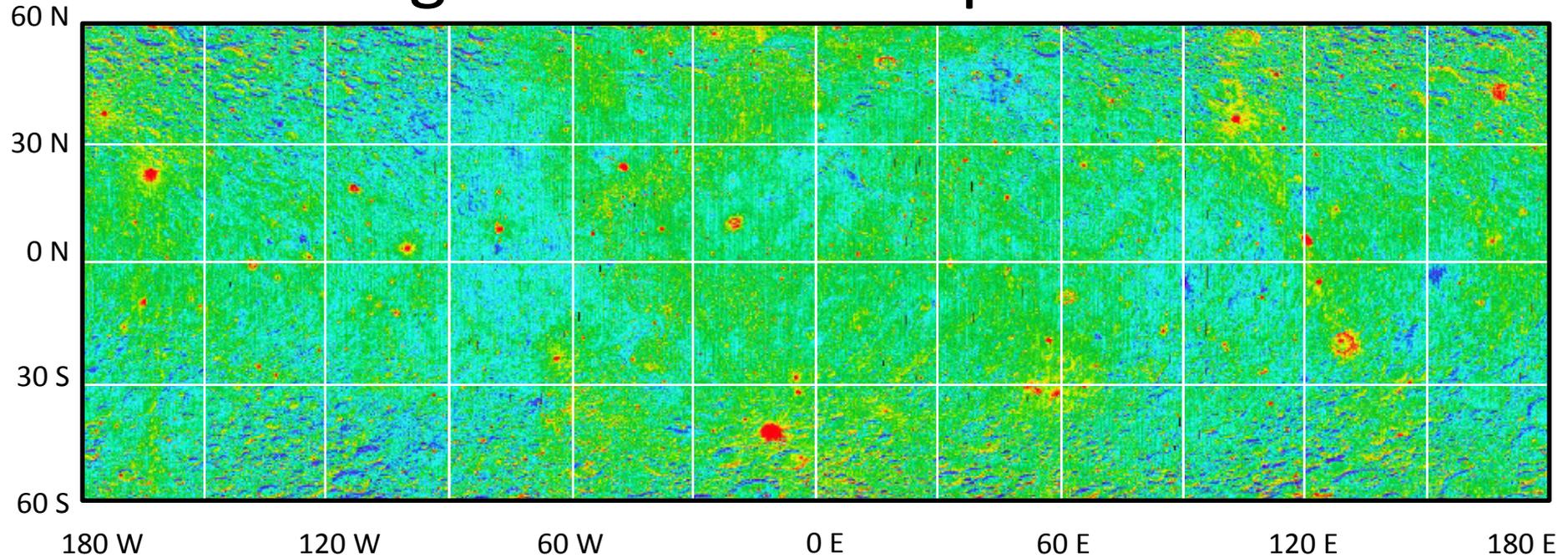
Average Rock Abundance – 10%



Less Rocky!

Average Rock Abundance – 1.3%

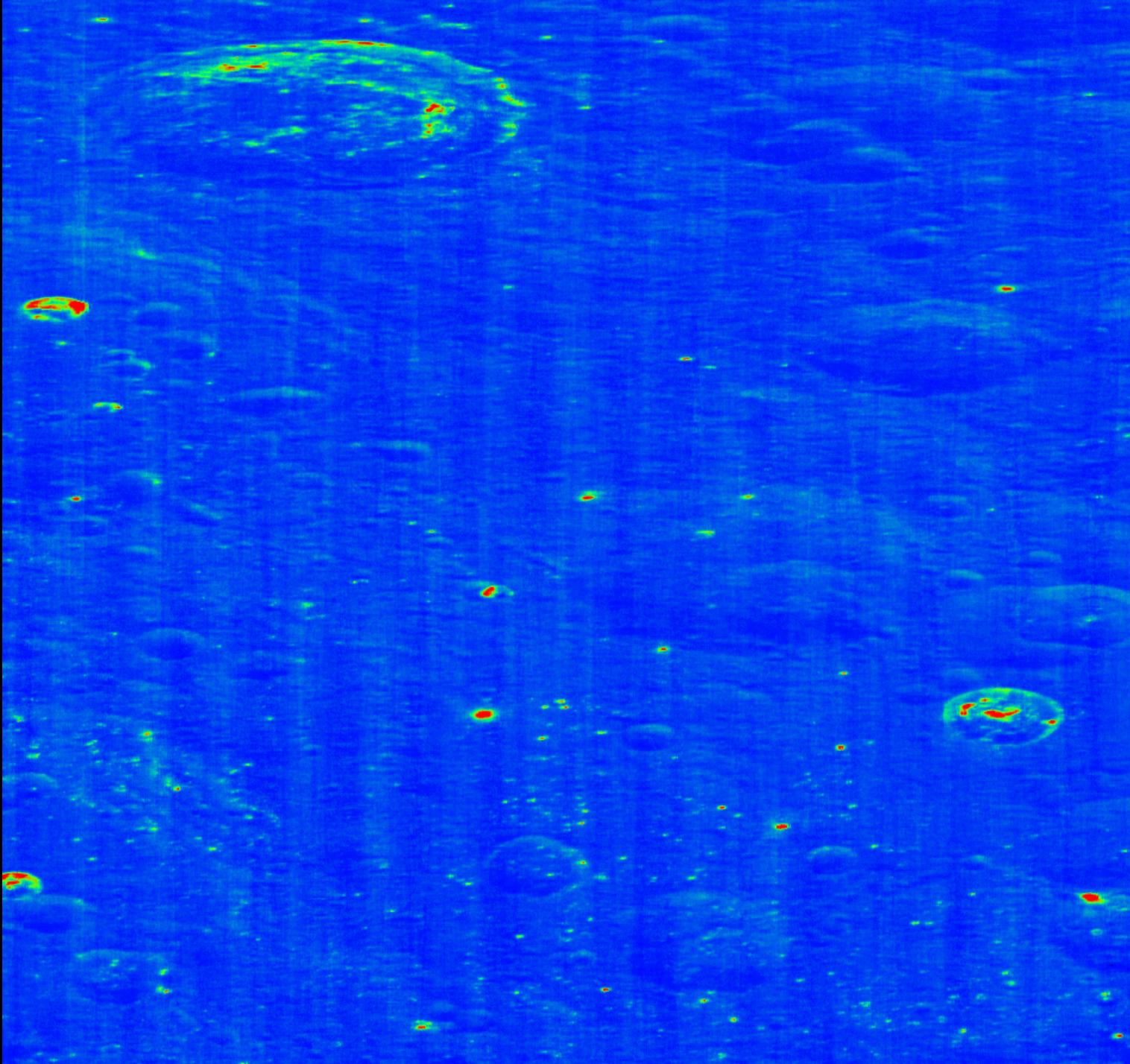
# Nighttime Soil Temperature



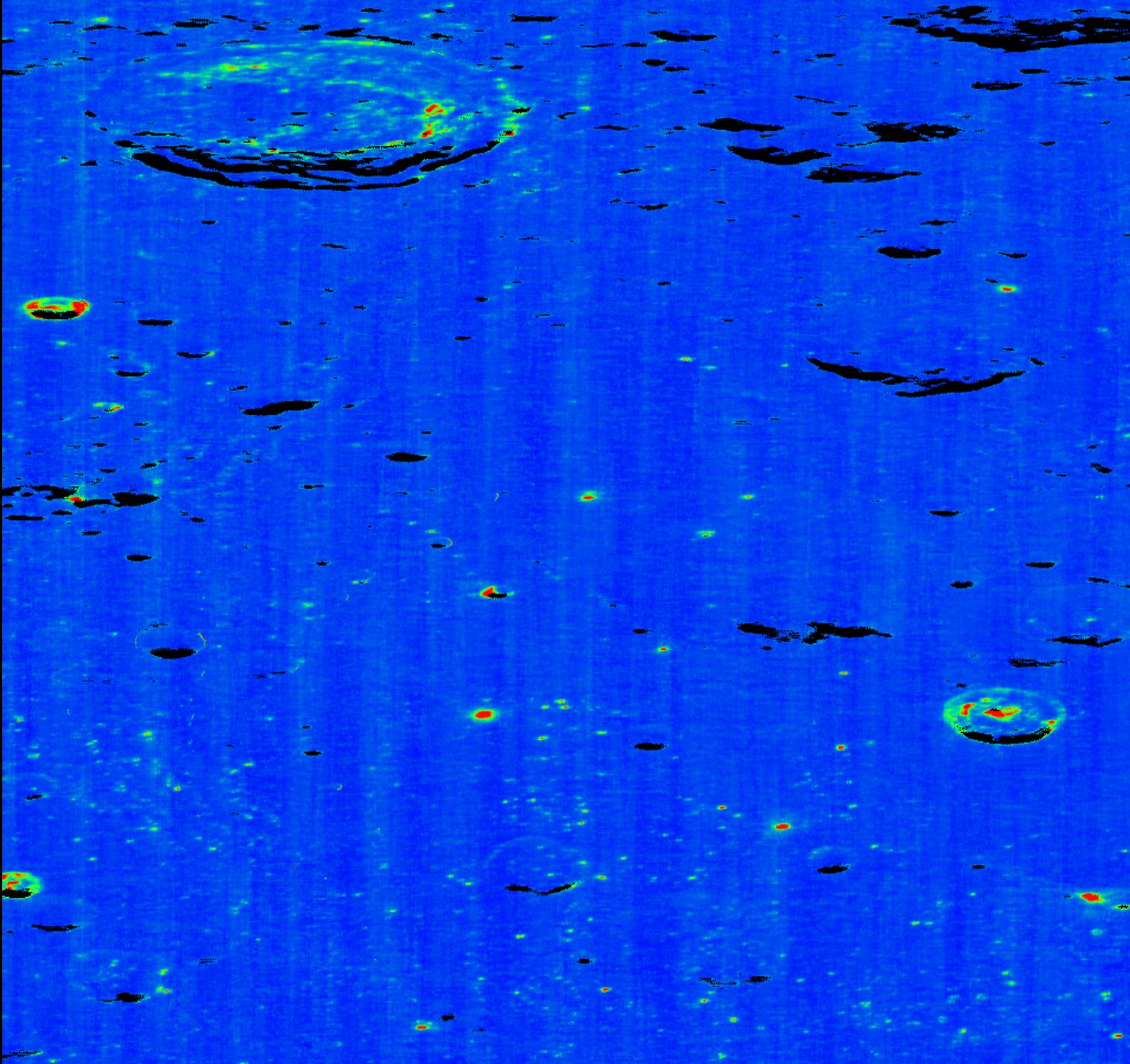
- Nighttime temperature of the modeled soil component
  - Soil Temperature (ST)
  - Soil Temperature Normalized (STN) to remove latitude variations (above)
- Rocky areas have elevated temperatures
- Cold anomalies at higher latitudes driven by topography
- Some Equatorial “cold spots”
  - Colder than average features associated with some small craters

# New 128 ppd RA Products

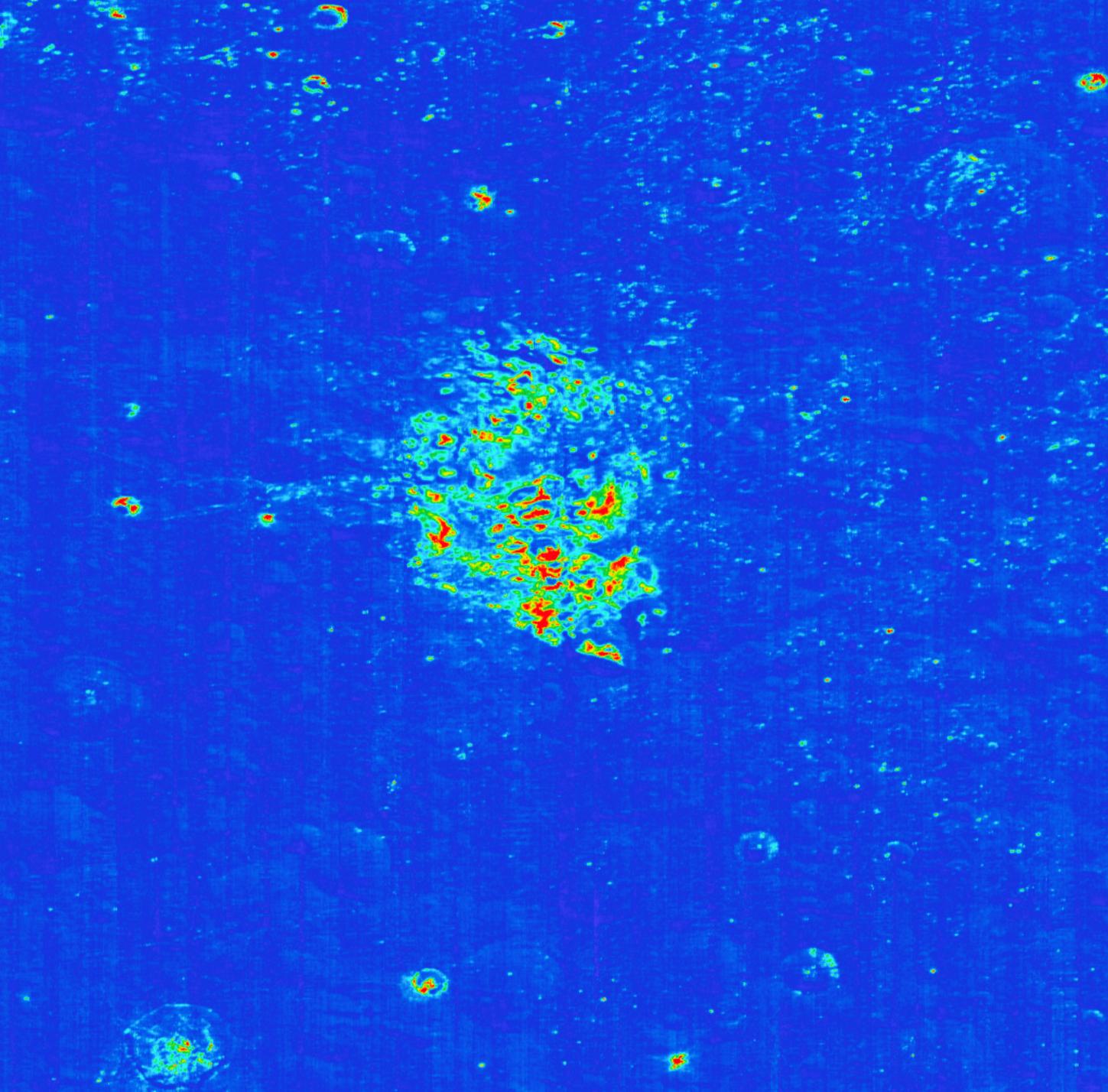
- 46 separate rock abundance, regolith temperature, and RMS fitting error maps
  - These maps parallel the nighttime Level 2 GDR products and are constructed from Diviner Ch. 6-8
- Local times are restricted to 19:30 to 05:30
- Includes topographic data from LROC DTM to determine local time and latitude
  - Used to adjust apparent local time and latitude
  - Rock abundance model now references the apparent local time and latitude to reduce topography effects.
- Latitude range extended to +/-80 degrees
  - Data on steep slopes at higher latitudes masked



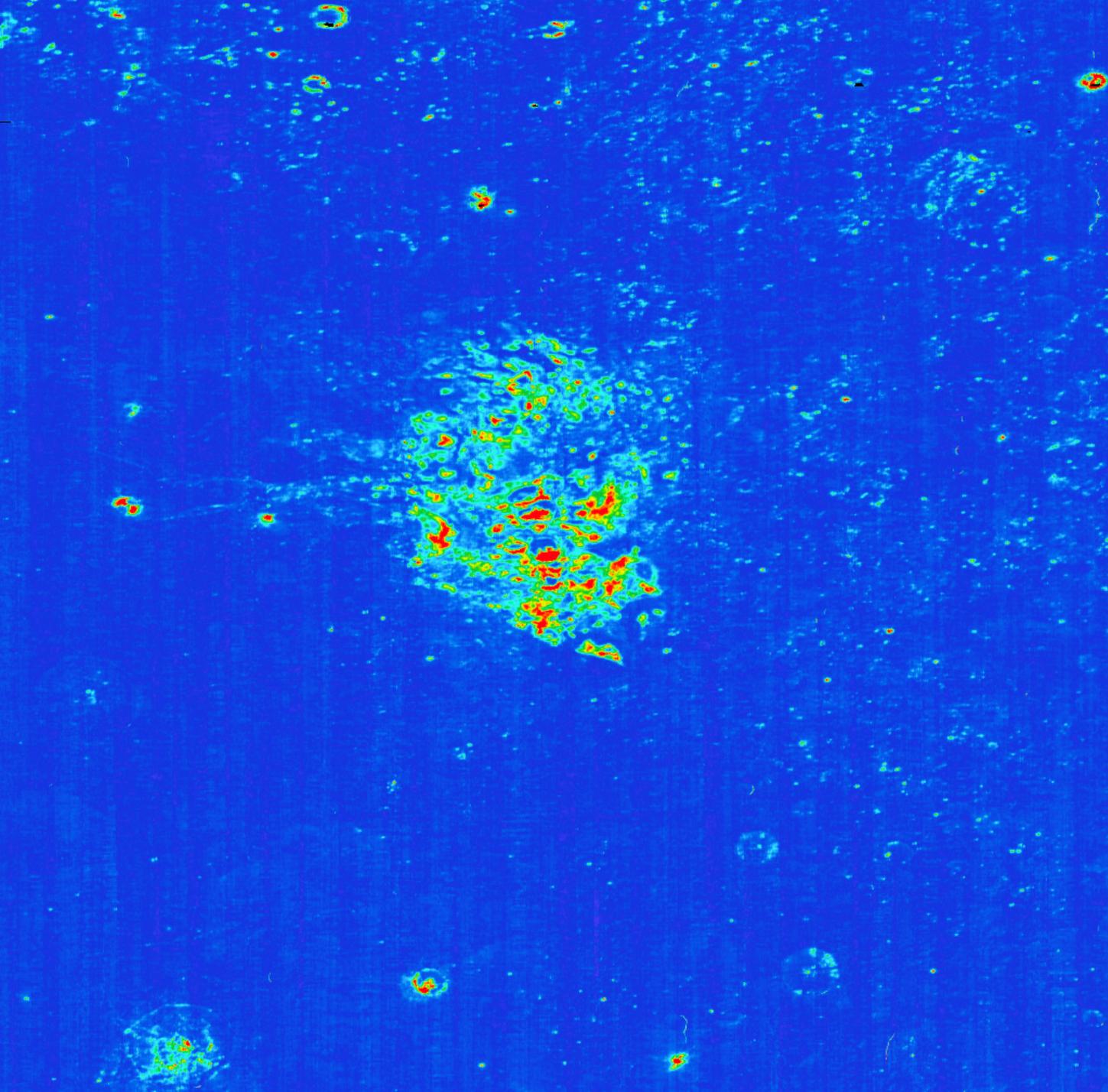
Old rock  
abundance –  
topography  
influences values  
at high latitudes



New rock  
abundance –  
pole facing  
slopes have  $>80^\circ$   
minimum solar  
incidence



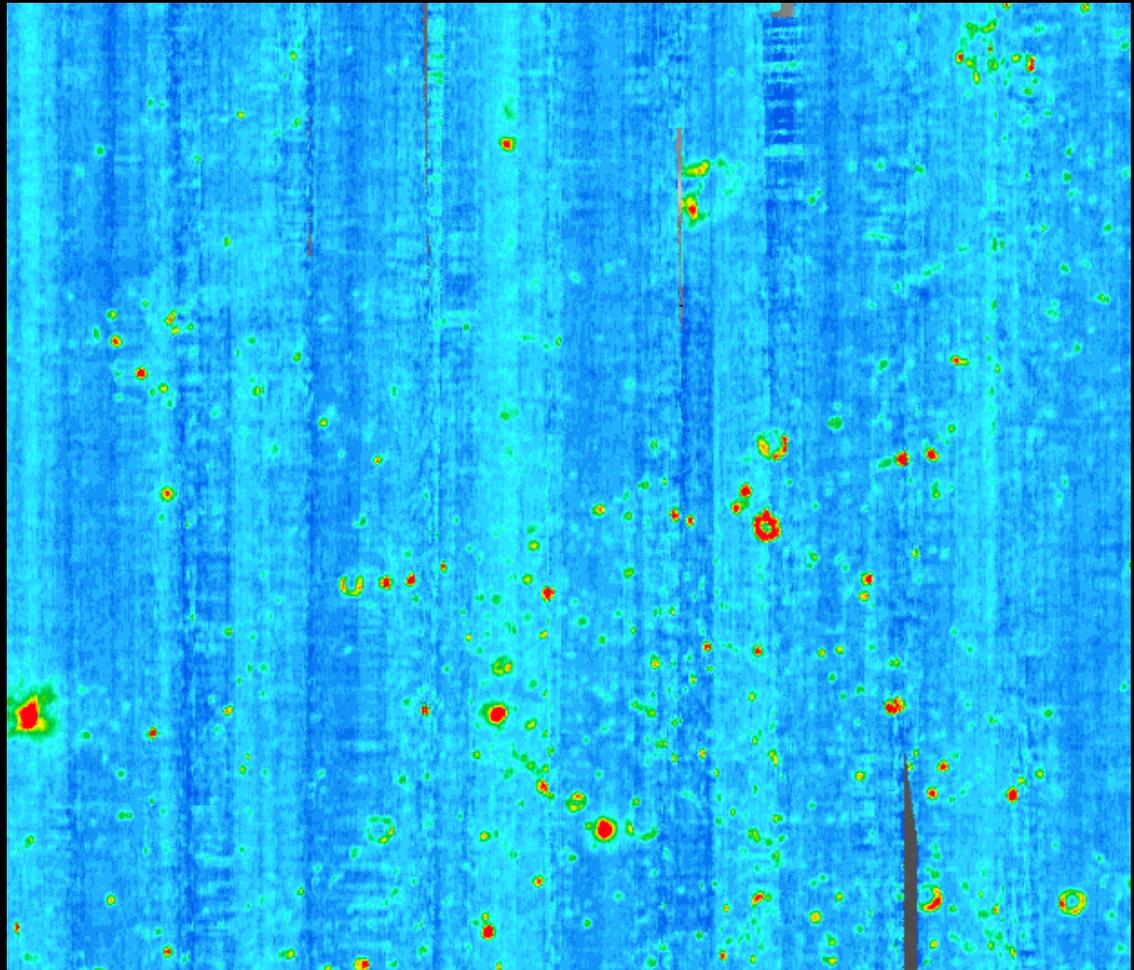
Old rock  
abundance –  
Tycho Antipode



New rock  
abundance –  
Tycho Antipode

# Improved Calibration and Rock Abundance

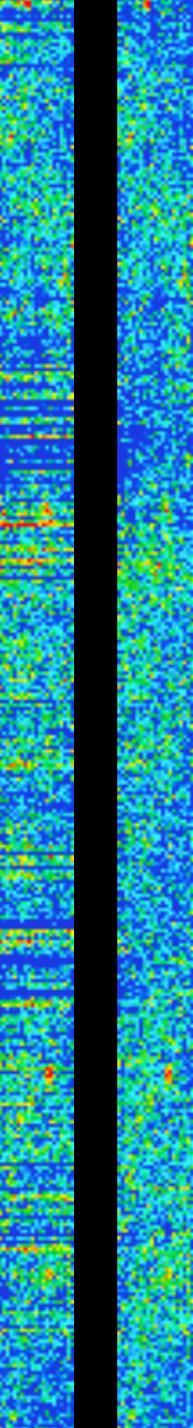
- Correlated noise is present in all Diviner detectors/channels
- This produces a “stuttering” effect present in rock abundance and regolith temperature maps



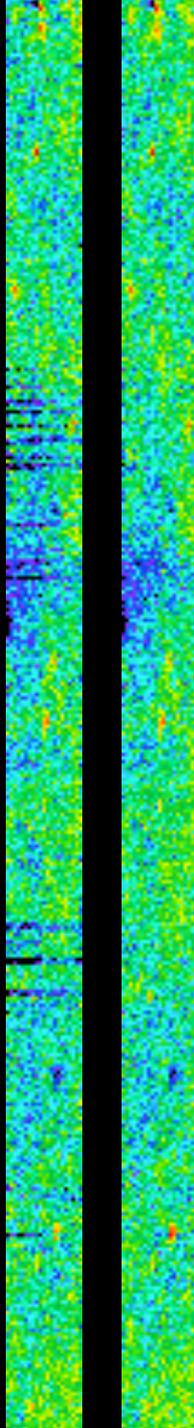
Rock abundance 128 ppd - “stuttering” is present at the ~0.5% level

# Data Quality Improvement

- New rock abundance maps will be produced from improved Diviner Level 2 data products



Rock Abundance  
0-2%  
Original (left) and  
corrected (right)



Regolith Temperature  
88-100 K  
Original (left) and  
corrected (right)

# Summary

- Diviner Level 3 Data Products
  - Standard Christiansen Feature Value (STD\_CF)
    - Cumulative Map – 128 ppd / 60S-60N
  - Normalized to Equatorial Noon CF Value (NEN\_CF)
    - Cumulative Map – 32 ppd / 60S-60N
  - Rock Abundance (RA)
    - Cumulative Map, Individual Map Cycles – 128 ppd / 80S-80N
  - Soil Temperature (ST)
    - Cumulative Map, Individual Map Cycles – 128 ppd / 80S-80N
  - Normalized Soil Temperature (STN)
    - Cumulative Map – 128 ppd / 70S-70N
  - Root Means Square (RMS)
    - Individual Map Cycles – 128 ppd / 70S-70N